R. B. WITTE JR.

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INSTRUMENT FLYING

A.A.F. Instrument Approach System

15 JANUARY 1945

INSTRUMENT FLYING

ARMY AIR FORCES

INSTRUMENT APPROACH SYSTEM

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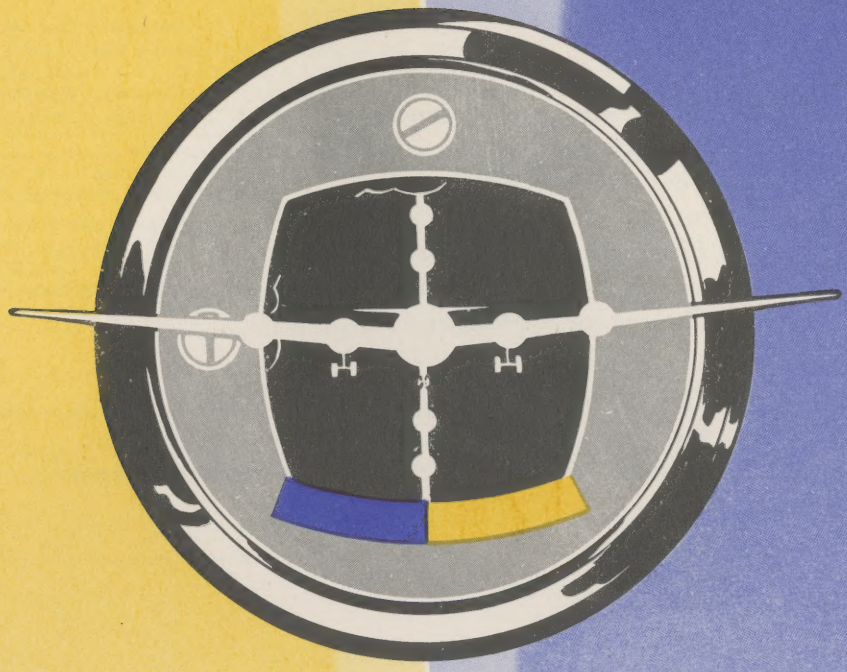


INTRODUCTION

In air operations against the enemy, as in all flying, weather has been, and will continue to be, the most limiting factor involved. Instrument let-down procedures on radio ranges and radio compass homing stations are feasible only if the ceiling and visibility are above relatively high minimums.

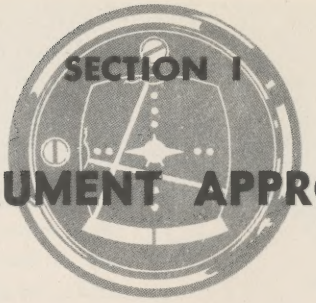
The U. S. Army Air Forces, recognizing this fact, has sponsored research and development of blind approach and blind landing systems over a period of years. The ultimate aim of such a program is to permit flight operations regardless of ceiling or visibility.

The AAF Instrument Approach System (SCS-51) represents a stage in this development. While it is realized that a pilot who has attained a high degree of instrument flying proficiency can frequently execute a successful blind landing with the localizer-glidepath equipment, actual instrument landing is not the intended purpose of this system. Rather, it should be regarded as a means by which a pilot may accurately descend from a known radio fix to a position a few feet above a runway or landing strip. The actual landing will then be accomplished by visual reference to the ground.

The use of VHF (very high frequency) transmitting equipment for the AAF Instrument Approach System is of notable interest. Few pilots are familiar with the characteristics peculiar to this new medium of transmission. It is not necessary that the pilot have a detailed technical knowledge of the glidepath-localizer system in order to fly it successfully. However, he should know what to expect of the equipment under various operating conditions.

The chief advantage of VHF lies in its freedom from static. Neither lightning nor corona static will have the slightest effect upon the operation of the glidepath-localizer receiving units or upon the action of the pilot's indicator needles. The sole effect of weather upon the SCS-51 is an indirect one, in that a heavy rain will change the moisture content of the ground, causing the glidepath beam to raise slightly.

In general, ultra high frequency beams are straighter and much less inclined to swing, fade, or form false courses than the conventional low frequency radio beam. However, the tendency of the transmitted energy to be reflected like light rays is much more pronounced in the higher frequency band. This tendency sometimes causes bends or ripples in the localizer or glidepath course. These can usually be eliminated by careful installation of the ground equipment.



THE AAF INSTRUMENT APPROACH SYSTEM

1. GENERAL DESCRIPTION.

a. The present transmitting equipment of the AAF Instrument Approach System is being installed at Army Air Forces fields and bases. This equipment is entirely self-contained and is mounted in a truck and trailer. Air-transportable equipment is also being developed, and permanent installations are being made by the CAA at various airports throughout the United States. The complete installation, known as Signal Corps Set 51 (SCS-51), consists of three independently-operated units:

(1) The Runway Localizer Transmitter

(2) The Glidepath Transmitter

(3) Three 75 mc. Marker Beacon Transmitters

b. The AAF Instrument Approach System, using SCS-51, provides the pilot with a straight-line glidepath beam and a runway localizer beam. To enable the pilot to follow the two beams, the aircraft is equipped with an Approach Indicator. This instrument consists of two crossed needles. The vertical needle supplies a visual indication of the lateral position of the aircraft with respect to the on-course of the localizer beam. The horizontal needle shows the relationship of the aircraft to the glidepath beam. When the aircraft is properly aligned on the approach path, the needles of the Approach Indicator are crossed in the center of the instrument. The three markers, when used in connection with the sensitive altimeter, provide a further check of position. After homing to the airport by any navigation aid available (that is, radio range, radio compass locator, or "H" facility), the aircraft will be flown to intersect the runway localizer path. After reaching the localizer path the flight is conducted by reference to the localizer needle indications. On the final approach, the aircraft is flown on the localizer at the desired altitude until the glidepath is intersected. The pilot then establishes a uniform rate of descent by reference to the combined indication of the localizer and glidepath.

c. The AAF Marker Beacon Indicator flashes when the aircraft passes over any of the three marker beacons. The radio compass must not be switched off. This action will render the Marker Beacon Receiver inoperative unless the aircraft is equipped with an independently operated Marker Beacon Receiver.

2. GROUND EQUIPMENT (SCS-51).

a. THE RUNWAY LOCALIZER TRANSMITTER —This transmitting equipment is a mobile, self-contained unit mounted in a truck, and is operated at a position approximately 1000 feet from the upwind end of the landing runway. If it becomes necessary to move the equipment, only a short time is required to resume normal operation in the new location.

The transmitter is crystal-controlled to one of six available frequencies, between 108.3 and 110.3 megacycles. The signal is split at the transmitter; one sector is modulated at 90 cycles per second, and the other sector is modulated at 150 cycles per second. For convenience in flight, these are designated as blue and yellow sectors. The *blue* sector (150 cycles) is transmitted to the *right* of the beam in respect to the *landing aircraft.* The yellow sector, then, is to the *left* of the landing aircraft.

The pattern is similar to a two-course radio range.The "on-course" beam is formed by the overlapping of the two signals, and is that area where the field strength of the two sectors is equal. It is directly over and extends along a line with the landing runway in both directions. The normal range of reception is 25 miles at 2500 feet. This range increases slightly at higher altitudes.

b. THE GLIDEPATH TRANSMITTER.—The transmitting equipment is a self-contained unit mounted on a small trailer. Its size makes it possible to load it into a large cargo-type aircraft, such as the C-47. Like the localizer, only a short time is required to place the transmitter in operation if the equipment is not in the desired place. The equipment is operated at a position 400 to 700 feet upwind from the approach end of the runway, and a maximum of 400 feet to one side of the centerline. Simple adjustments make the transmitter operative at either side of the runway.

The transmitter is crystal-controlled to one of three frequencies: 332.6, 333.8 or 335 megacycles. The pattern produced is similar to the localizer, except the "on-course" lies in a nearly horizontal plane. The normal glidepath extends from the transmitter at an angle of approximately 2½ degrees. This angle, however, is adjustable from 2 to 5 degrees, as required by local terrain features. The transmitting antenna is so designed that the glidepath on-course is directed along the front beam of the localizer. When used together, these form the landing approach path.

It is to be noted that false glidepath courses exist at angles above 15 degrees to the horizontal. Flight along these false courses is not possible in normal operation because their high angle would require a rate of descent of 5000 feet per minute or greater.

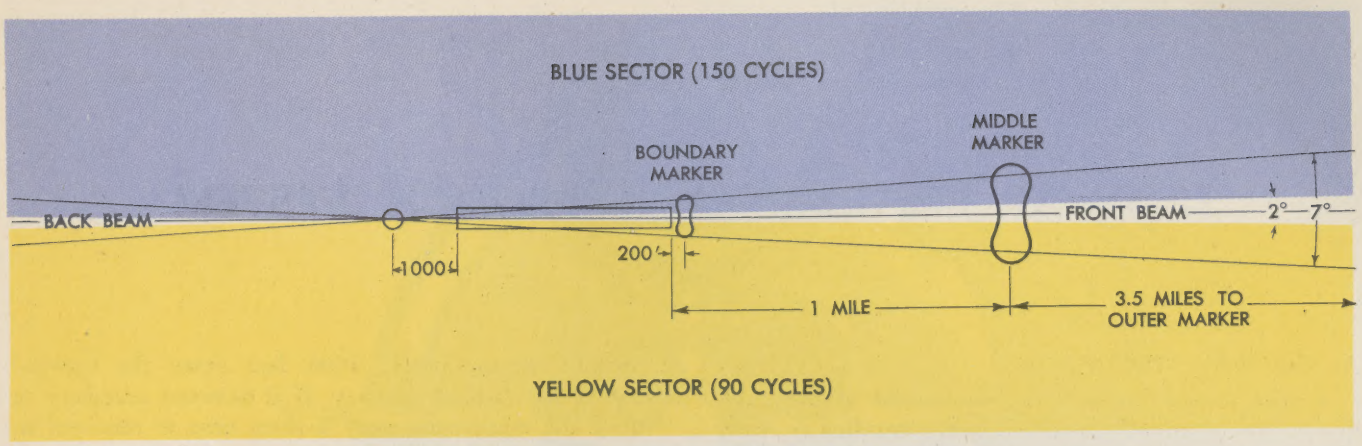


Figure 1—Runway Localizer Installation

c. THE MARKER BEACONS.

(1) *The Outer Marker.*—This unit is placed 4.5 miles from the point of landing, or 3.5 miles from the Middle Marker. It consists of a very high frequency transmitter, emitting two dashes per second. It has a vertical fan-shaped pattern.

(2) *The Middle Marker.*—This station is placed 1 mile from the point of landing, or 4500 to 4800 feet from the end of the runway, and transmits a signal keyed to six dots per second. The pattern is identical to that of the outer marker.

(3) *The Boundary Marker.*—This station is placed 200 feet downwind from the approach end of the runway. The signal emitted is unkeyed.

NOTE: The above distances are subject to minor variations because of terrain, or inaccessibility of transmitter operation locations.

3. AIRBORNE EQUIPMENT.

a. THE LOCALIZER RECEIVER.—The receiver installed in the aircraft for use with the Runway Localizer Transmitter is remotely controlled by a small box installed near the pilot's seat.

The localizer will be operating on one of six available frequencies. These are indicated by the letters U, V, W, X, Y, Z inscribed on the control box. These letters correspond to the following frequencies:

U—108.3 mc.	X—109.5 mc.
V—108.7 mc.	Y—109.9 mc.
W—109.1 mc.	Z—110.3 mc.

To operate the equipment the main switch is turned "ON" and the selector switch turned to the desired frequency. After a warm-up period of 3 to 5 minutes the set is ready for use. In order to check the source of the localizer signal being received, the pilot may turn the volume control knob to the full volume position. A two or three letter identification signal transmitted by the localizer will be heard in the headphone. When the pilot has ascertained that he is receiving the desired localizer signal, he may adjust the volume to a comfortable level. The volume should not be turned down completely, since it affords the pilot assurance that the localizer transmitter is operating. The volume control knob has no effect upon the sensitivity or reaction of the localizer indicator needle.

The Approach Indicator installed on the instrument panel will indicate, by deflection of the vertical needle of the indicator, the color area of the sector in which the aircraft is then flying. If the aircraft is flying off-course in the blue area of the transmitter, the needle will be deflected into the blue area of the indicator.

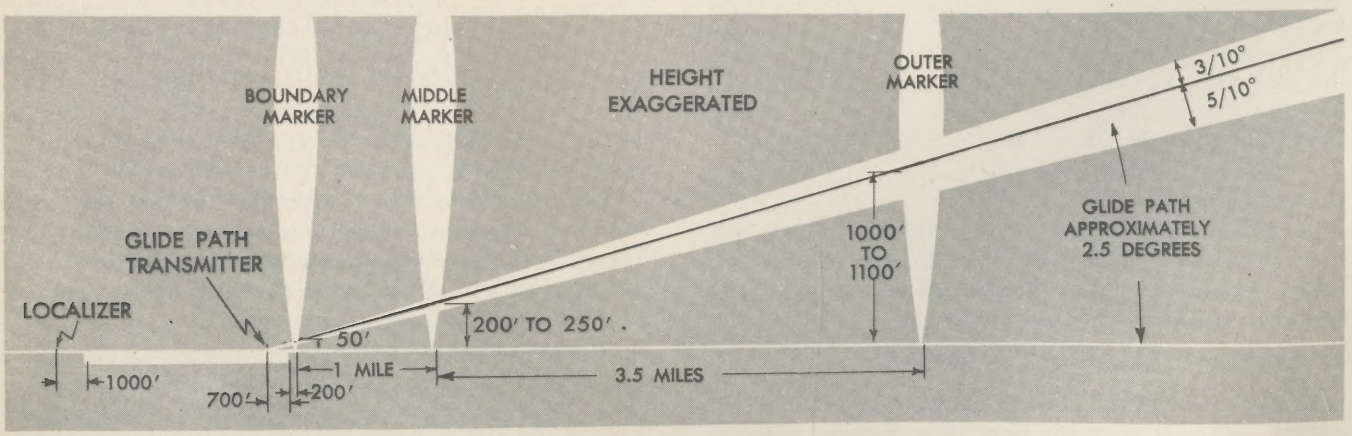


Figure 2—Glidepath Installation and Marker Beacons

If the aircraft is flying in the yellow sector, the needle will be deflected into the yellow area of the indicator. The direction toward the beam will not necessarily be indicated by this needle deflection. The following should be noted with reference to the needle action:

(1) When the aircraft is flying on the front beam of the localizer and is headed toward the runway, the action of the needle is directional; that is, when the needle points right, the aircraft must be turned to the right to regain the center of the localizer beam. This needle action also applies when flying on the back beam and the aircraft is headed away from the station transmitter.

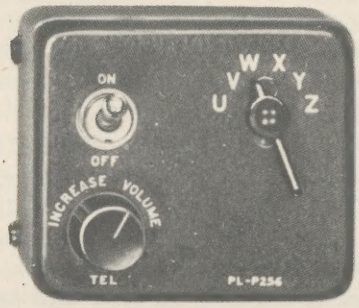


Figure 3—Runway Localizer Control Box

(2) When the aircraft is flying on the localizer and is headed away from the runway on the front beam, the sensing of the needle will be reversed. To regain the center of the localizer beam in this case, the direction of turn must be away from the needle.

REGARDLESS OF THE POSITION OR HEADING OF THE AIRCRAFT, THE NEEDLE WILL ALWAYS BE DEFLECTED IN THAT COLOR AREA IN WHICH THE AIRCRAFT IS FLYING.

When the aircraft is headed toward the runway on the front beam, the blue area is on the right. Since the beam will be on the left of an aircraft flying off-course in the blue area, a correction of heading toward the *left* would be necessary to regain the on-course.

The needle is very sensitive and will give a full-scale deflection when the aircraft is 3.5 degrees to either side of the on-course. This high degree of sensitivity permits the use of the indicator for accurate runway localization. If the pointer is no further off-center than one-quarter scale the aircraft will land on the runway. Five thousand feet from the localizer transmitter a one-fourth scale deflection indicates a distance of 75 feet from the center of the on-course.

b. THE GLIDEPATH RECEIVER.—Three types of receivers are installed in aircraft for use with the glidepath. To the pilot the main difference between them is the manner in which tuning can be accomplished.

(1) The older unit (R-47), with a superregenerative circuit, is *fixed-tuned* to a *frequency of 335 mega-*

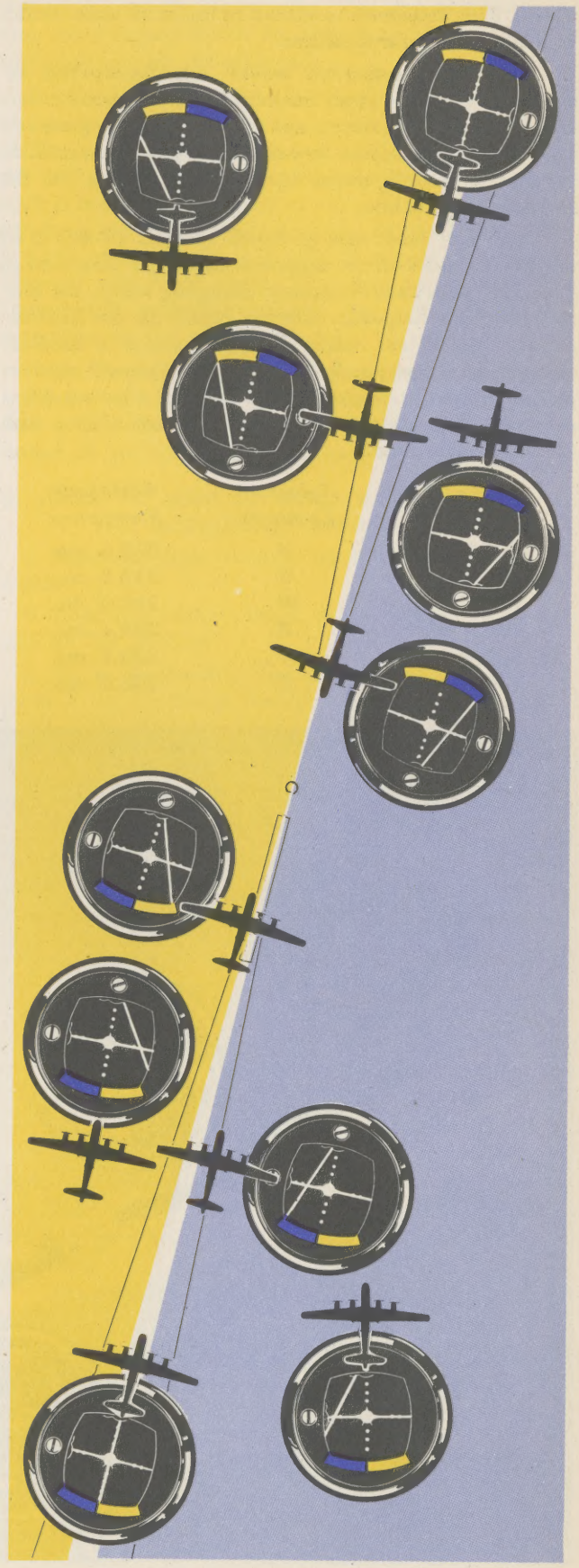


Figure 4—Localizer Needle Action

cycles. This receiver is operated by the same main switch which controls the localizer.

(2) The production model superheterodyne receiver (R-57) has three interchangeable crystals covering 332.6 mc., 333.8 mc., and 335 mc. A radio mechanic can install the desired crystal in a few minutes. This receiver is also operated by the main switch on the localizer control box.

(3) The latest type glidepath receiver (R-89) is an improved model of the superheterodyne set described in (2). The glidepath frequency changing relays are connected to the frequency selector switch on the localizer control box. Thus, when the pilot selects a localizer channel, he automatically switches the glidepath receiver to the proper frequency. Every localizer channel has a corresponding glidepath frequency, in accordance with the following table:

Localizer Frequency	*Selector Channel*	*Glidepath Frequency*
108.3 mc.	U	332.6 mc.
108.7 mc.	V	333.8 mc.
109.1 mc.	W	335.0 mc.
109.5 mc.	X	332.6 mc.
109.9 mc.	Y	333.8 mc.
110.3 mc.	Z	335.0 mc.

After the initial warm-up period, the pilot's Approach Indicator will indicate the position of the aircraft with respect to the glidepath by the deflection of the horizontal needle. When the aircraft is above the desired glidepath, the needle is deflected downward, and if the aircraft is below the desired path, the needle is deflected upward.

THE GLIDEPATH NEEDLE ALWAYS POINTS IN THE DIRECTION THE AIRCRAFT MUST BE FLOWN TO APPROACH THE GLIDEPATH. THIS IS TRUE REGARDLESS OF THE HEADING OF THE AIRCRAFT.

The needle is extremely sensitive and will give a full-scale deflection when the aircraft is 0.5 degrees below the glidepath or 0.3 above the glidepath. This requires that the aircraft be aligned quite accurately on the glidepath at some distance from the field. Only very minor corrections are allowable near the ground.

The horizontal needle will normally be set to give a fly-up indication when the receiver is "ON," but no signal is being received. This is done to reassure the pilot; thus he receives an "on-course" indication *only* when the equipment is working properly and the aircraft is on the desired glidepath.

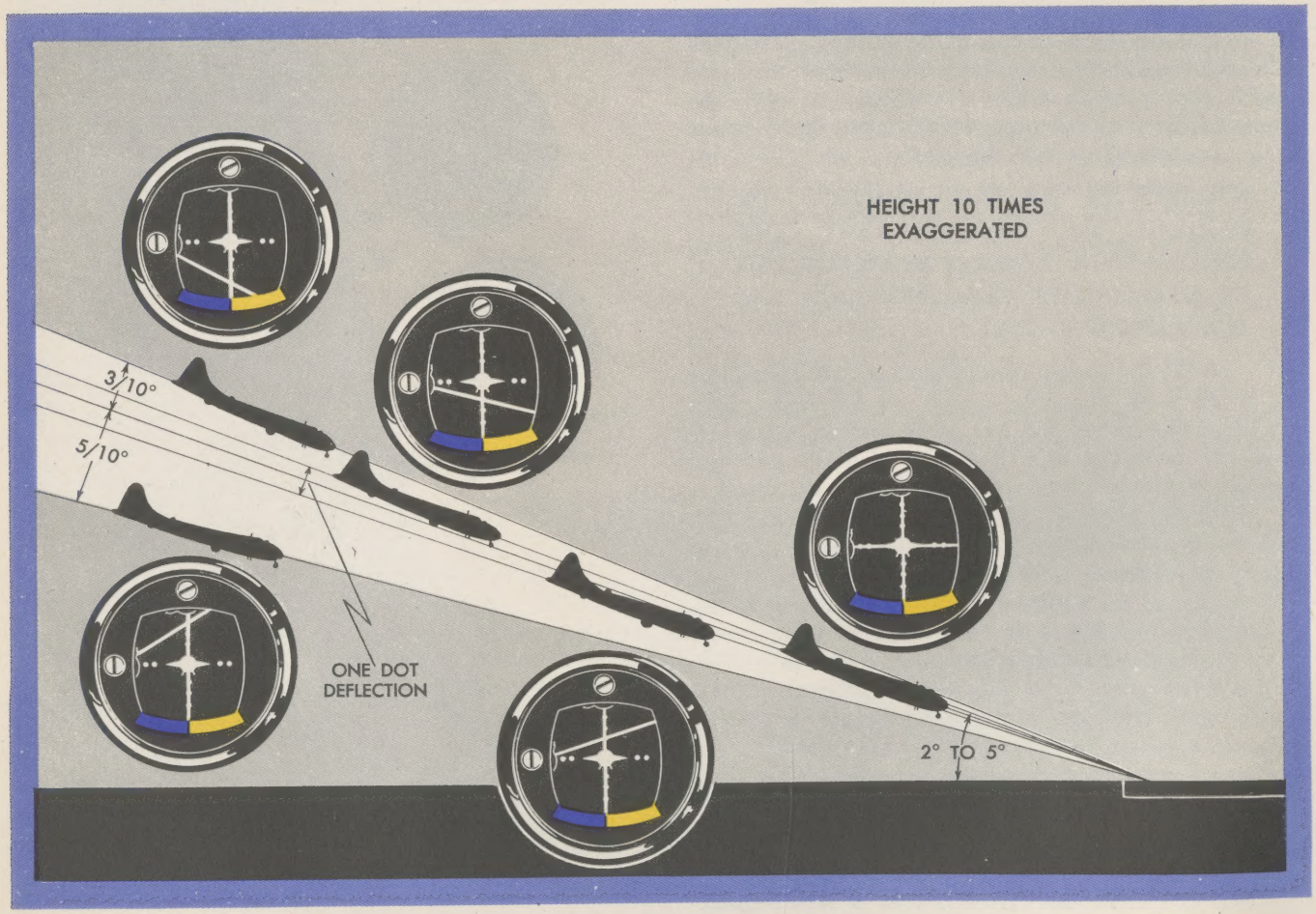


Figure 5—Glidepath Needle Action

4. FLIGHT PROCEDURES.

a. PRELIMINARY PROCEDURES.—All permanent installations of the combined localizer and glidepath system in the United States will be at airfields also equipped with a radio range station. In these cases, the aircraft will be flown to the radio range station as in normal airways flying. The pilot, while maintaining flight altitude, will contact the control tower for the altimeter setting and his approach clearance. The localizer and glidepath units in the airplane will then be turned ON by the switch located on the control box. When the receivers are warmed up (3 to 5 minutes), the desired localizer and glidepath frequencies are selected by placing the selector switch on the proper frequency channel. The pilot will then turn up the volume control and check the localizer identification signal. At this time the "Before Landing" cockpit check is made.

b. INTERSECTING THE LOCALIZER BEAM.—After having set the altimeter and being cleared to land, the pilot will fly a course which will intersect the localizer beam. As he approaches the beam, he will observe the localizer needle. The needle will move from its original full-scale deflection toward center as the aircraft nears the "on-course." As soon as this movement begins, the pilot will start a turn to the *outbound* heading of the front localizer beam. This should place the aircraft close enough to the center of the "on-course" so that subsequent bracketing may be easily accomplished. The pilot should observe the localizer needle carefully to detect any slight tendency for the needle to leave the center of the instrument. Wind-drift and compass error will be quickly detected in this manner.

c. BRACKETING THE LOCALIZER. — On the outbound heading the needle will point to the correct color areas, but sensing will appear reversed. To hold the center of the "on-course," all corrections must be made away from the needle. Corrections will be made by reference to the directional gyro, and this instrument will be used to hold the aircraft on-course, and flying in line with the runway.

The aircraft should be flown out the localizer beam until time to start the procedure turn. This time will be determined from the procedures outlined in T. O. No. 08-15-4. To make the procedure turn, the pilot turns 45 degrees from the beam and holds his new heading 40 seconds. He now begins a standard-rate turn back to the inbound heading of the beam. Upon completion of this turn, the aircraft should be approximately on-course and flying in line with and towards the runway. As the procedure turn is completed, a descent is made to 1000-1100 feet above the ground. The Outer Marker is crossed at that altitude, and with a standard installation, the glidepath will be intersected at this point.

When the procedure turn has been completed, the needle indications of the localizer and glidepath are directional, and any necessary corrections to be made will be toward the two needles. The approach path can now be precisely flown by following the localizer in conjunction with the glidepath.

d. MARKER INDICATIONS.—If the aircraft is following a proper glidepath, it will pass over the outer marker at an altitude of 1000 to 1100 feet. Passage over the Middle Marker will be at 200-250 feet. If the aircraft is below the glidepath at any point, *fly level, maintaining a constant altitude* until the on-course indication is again received. *Do not attempt an abrupt climb to intersect the beam again.* This not only produces a dangerously nose-high attitude, but also causes over-correction on the glidepath beam.

The Boundary Marker will cause the Marker Beacon Indicator to flash on. This indicates the safe landing area is just ahead, and a normal descent may be continued all the way to ground contact.

5. ITEMS TO KEEP IN MIND WHILE FLYING THE INSTRUMENT APPROACH SYSTEM.

a. Maintain flight altitude until in contact with the tower.

b. Complete cockpit check upon crossing range station or "H" facility.

c. Know the landing base either by careful reference to an Army Air Forces Instrument Approach Procedures book, or by personal acquaintance with same.

(1) Check heading of the landing runway.

(2) Obstructions to landing.

(3) Altitude of landing runway.

(4) Relation of the radio range legs to the localizer beam.

d. Get latest altimeter setting and carefully set altimeter.

e. Outbound:

(1) Determine drift and compass error.

(2) Remember that when flying the *outbound* heading, *turn away from the needle.*

f. Inbound:

(1) If the procedure turn is completed and the localizer needle is not centered, turn to intercept the beam at a *maximum of 30 degrees.*

(2) As the procedure turn is completed, recheck landing gear and adjust power setting for a uniform approach.

(3) *On the inbound heading, fly toward the needles.*

(4) *Large corrections are undesirable and unnecessary.* Once on the beam, taking the drift into consideration, any turn over 10 degrees either way from the landing heading will usually result in an unsuccessful approach.

(5) *Give the airplane time to react to a correction.*

(6) *Avoid large corrections near the ground.*

(7) DO NOT BE TOO PROUD TO PULL UP AND GO AROUND.

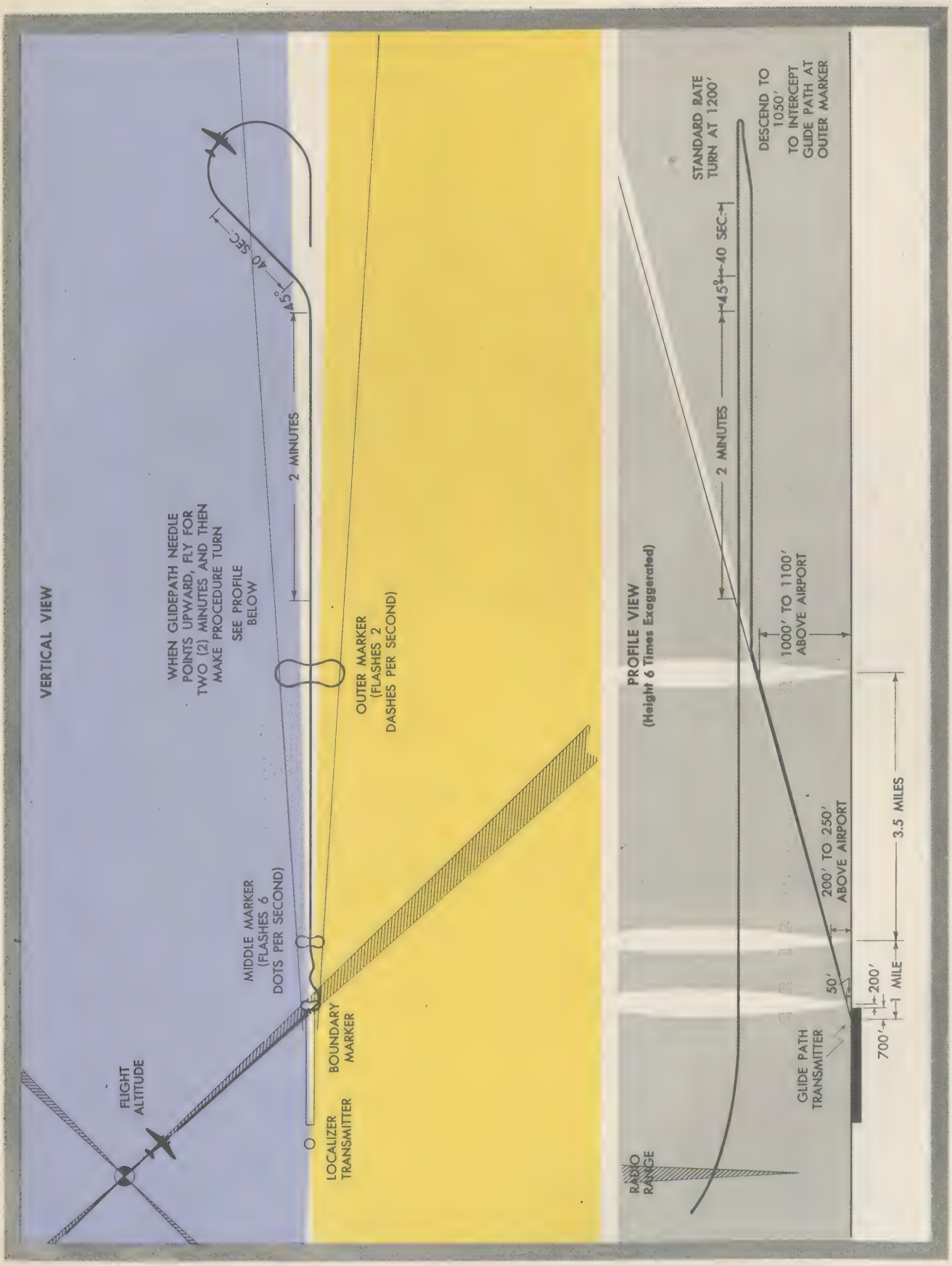


Figure 6—Complete Flight Procedure; AAF Instrument Approach System

6. TYPICAL INSTRUMENT APPROACHES.

a. Flight procedures for the great majority of SCS-51 installations encountered will conform with one of the three typical approaches illustrated in Figures 7, 8 and 9. The essential difference in these procedures is with the initial approach, wherein the pilot discontinues the use of radio range or "H" facility and turns to his Approach Indicator as a means of navigation.

b. At Bryan, Texas (Figure 7), the range station is aligned with the landing runway, on the front beam of the localizer, approximately 4.5 miles from the point of landing. Therefore, the "Z" marker at this station is used as the Outer Marker Beacon. The localizer beam is coincident with the northwest-southeast leg of Bryan range. Approaching Bryan under instrument conditions, the pilot will fly to the range station or the radio compass homing facility located on the same site. Upon passing over the station he will start a turn to bracket the localizer beam (outbound heading 305 degrees) and descend to 1500 feet (m.s.l.). Flight will be maintained at this altitude until the glidepath needle swings upward, and for two minutes thereafter. Then a normal procedure turn will be accomplished, and the approach completed in the usual manner.

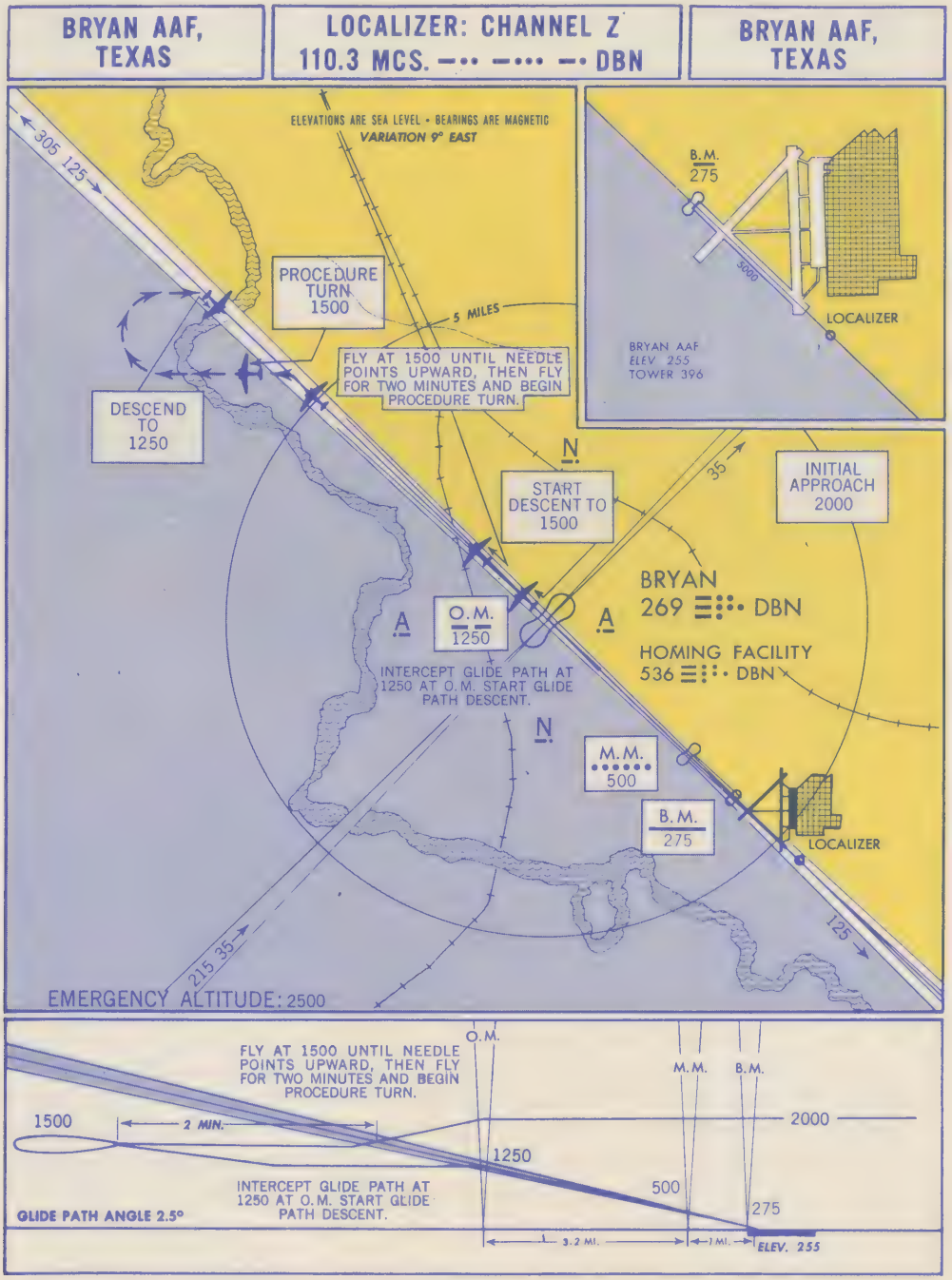


Figure 7—AAF Instrument Approach—Bryan

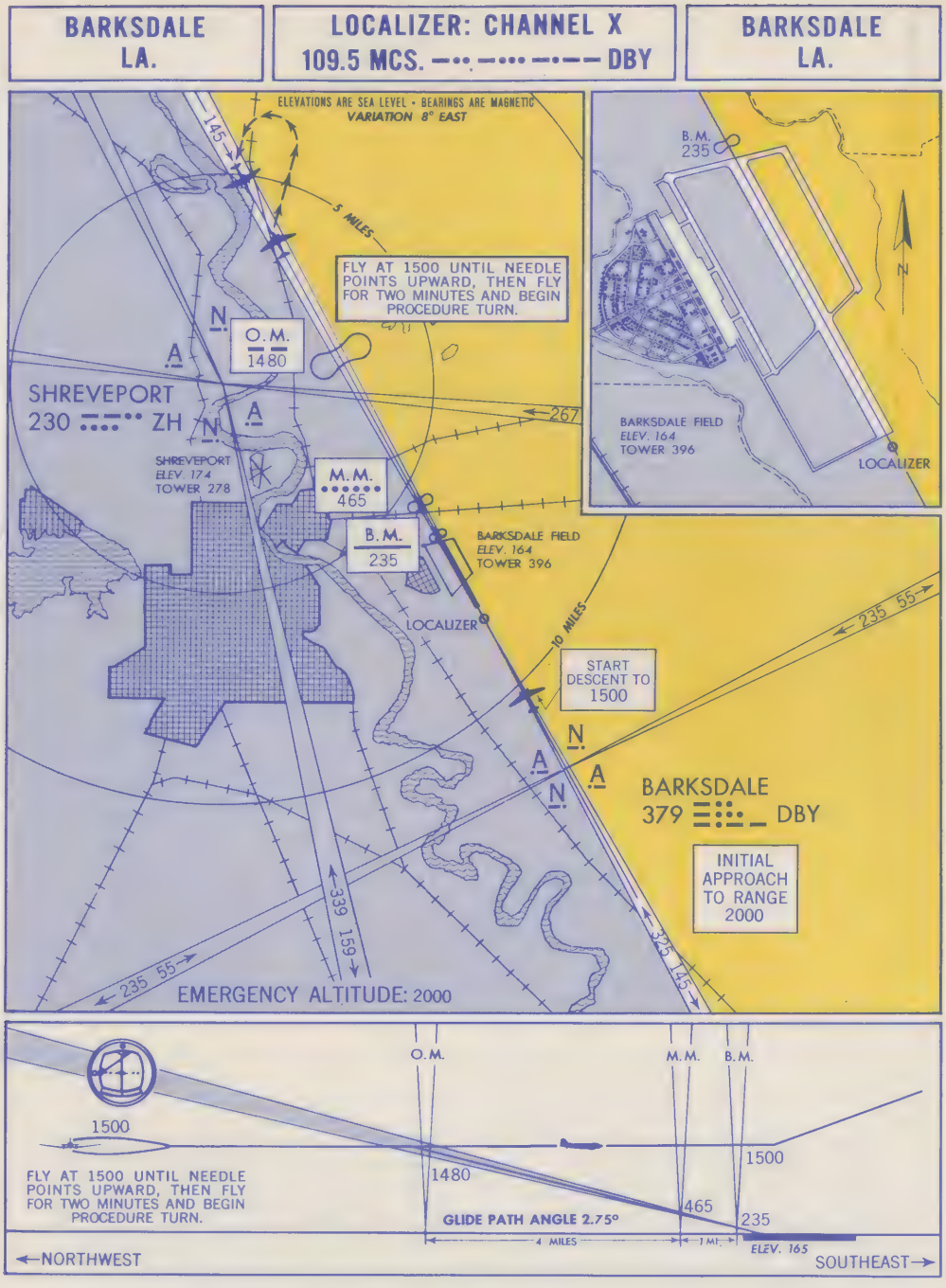


Figure 8—AAF Instrument Approach—Barksdale

c. Figure 8 illustrates the approach procedure for Barksdale, La. Here the range station is on the back beam of the localizer. Upon crossing the range station, the pilot will bracket the localizer beam toward the field. As the aircraft passes over the localizer transmitter, the vertical needle should be deflected rapidly from one side of the indicator to the other several times. Flight will be continued past the Outer Marker Beacon for the specified time until the procedure turn is started.

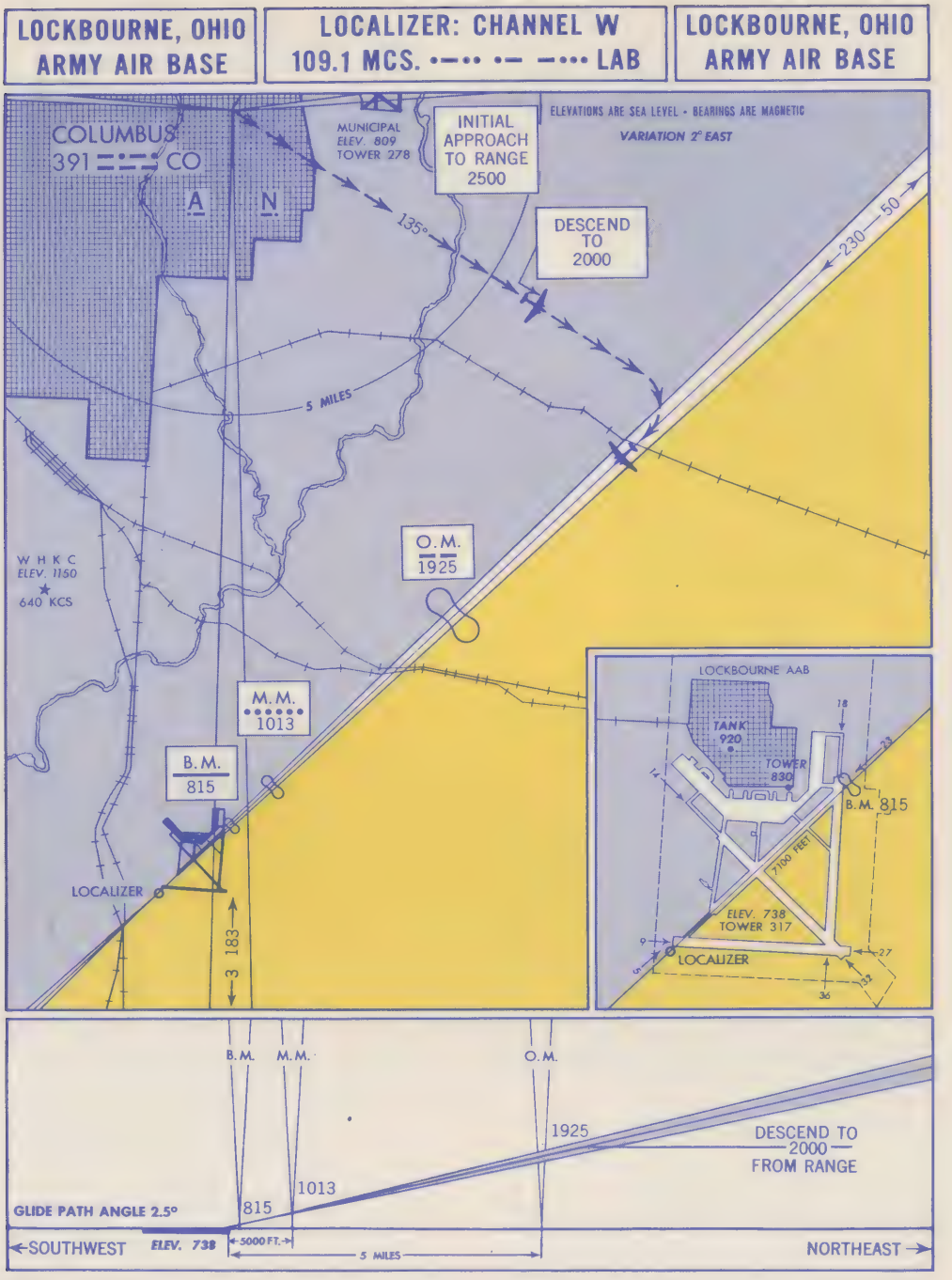


Figure 9—AAF Instrument Approach Chart—Lockbourne

d. The procedure for Lockbourne, Ohio, is shown in figure 9. In this case, the range station is located to the side of the localizer beam. The pilot flies from the range station by dead reckoning on a heading perpendicular to the localizer beam heading. When the vertical needle on the pilot's indicator shows that the beam has been reached, the aircraft is turned to the beam heading, and bracketing is started.

SECTION II

THE LOCALIZER APPROACH

1. GENERAL DESCRIPTION.

a. In the event of failure of the glidepath equipment, either ground or airborne, an accurate approach may be made with the localizer and marker beacon stations. In an approach of this type, the localizer beam furnishes directional alignment with the runway, while the sensitive altimeter, checked against the marker beacons, is used to control the descent. The limiting factor in the localizer approach is the comparatively wide tolerance of the standard altimeter.

b. For any given installation, the flight pattern for the localizer approach is essentially the same as the glidepath approach, and success of the let-down is directly dependent upon the operation of the marker beacon equipment. The pilot should first make a "test run" to check this equipment by flying along the localizer beam (either inbound or outbound) and observing the indications of the marker beacon light on his instrument panel.

2. FLIGHT PROCEDURES.

a. Upon arriving over the range station, the pilot will call the control tower and request clearance to make an instrument approach on the localizer-glidepath equipment. If the tower replies that the glidepath transmitter is inoperative but ceiling and visibility at the field are high enough to warrant a localizer let-down, the following procedures must be used:

b. PRELIMINARY PROCEDURES:

The pilot will first obtain the latest altimeter setting and carefully set the altimeter. He then turns to a heading which will intersect the back beam of the localizer. The initial bracketing turn will be toward the nearest marker beacon. Having once established a heading which keeps the localizer needle centered, flight over the marker beacon stations will be made at an altitude of 1200 feet above the airport to check the operation of the marker beacon equipment. (This altitude may vary with terrain features at the installation.) If the marker beacon receiver is operating and any one of the three marker beacons is not received, the pilot should not continue the procedure until the tower has been requested to check the operation of the equipment. After ascertaining that the marker beacon equipment is functioning properly, flight is outbound on the front beam of the localizer for a period of one to three minutes from the time of passage over the outer marker. At this time a regular procedure turn is started.

c. LET-DOWN PROCEDURE.

After the procedure turn has been completed, the *landing gear is rechecked* and a descent made to an altitude of 1050 feet above the level of the airport. The outer marker is crossed at that altitude, and power is adjusted for let-down as indicated in the applicable operating instructions for the type of aircraft being flown.

From the outer marker to the runway, the aircraft should follow a descending path as close as possible to that formed by the glidepath. The necessary rate of descent required to establish a proper glidepath will depend upon the let-down airspeed of the aircraft. The following table gives the necessary rate of descent in feet per minute for various let-down airspeeds:

Airspeed	*Rate of Descent*
100 m.p.h.	380 f.p.m.
110 m.p.h.	420 f.p.m.
120 m.p.h.	460 f.p.m.
130 m.p.h.	500 f.p.m.
140 m.p.h.	540 f.p.m.
150 m.p.h.	575 f.p.m.
160 m.p.h.	610 f.p.m.
170 m.p.h.	650 f.p.m.

The altitude over the outer and middle marker must be 1000 to 1100 feet and 200 to 250 feet respectively. The boundary marker, indicating that the safe landing area is just ahead, is crossed at 50 feet. At this point the pilot should be in visual contact with the ground and the established descent can be continued to a landing.

3. ITEMS TO KEEP IN MIND WHILE PERFORMING A LOCALIZER APPROACH.

a. The cautions to be observed when making an approach on *both* the glidepath and localizer are also applicable when making an approach on localizer beam alone. In the latter case, however, *more* attention must be devoted to the altimeter and marker beacons on the final approach. This is necessary because the combined indications of these instruments are the *only* means of establishing a safe and accurate glidepath.

b. As each marker is passed, the altimeter should be checked to see if the aircraft is too high or too low. Necessary correction in the rate of descent will be determined by this check, and the control technique is the same as though the glidepath were in operation.

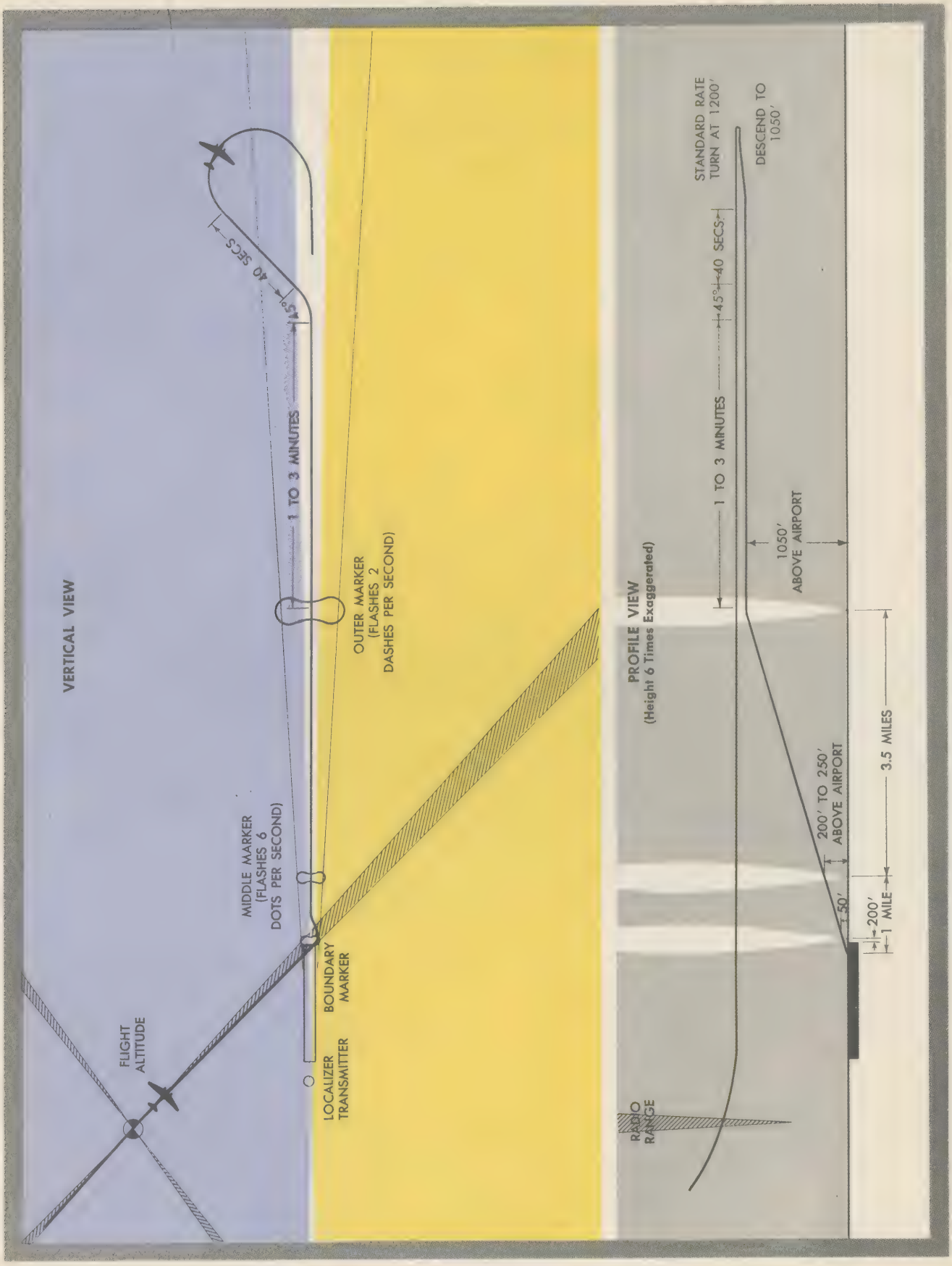


Figure 10—Complete Localizer Approach Procedure

SECTION III
ORIENTATION

1. FLIGHT PROCEDURE.

a. Normally, the pilot homes on a radio range or a radio homing station, and intercepts the localizer-glidepath course from this known position. In such case it is not necessary to work an orientation problem on the localizer. However, circumstances may arise when the homing station cannot be utilized because it is inoperative, or due to partial failure of the airborne radio equipment. If the localizer-glidepath receiver is still operative, an orientation problem can be flown and a let-down completed on this installation.

The frequency channel on which the localizer is operating will be known to the pilot. He will also know the position of the equipment relative to the runway, and the inbound magnetic bearings of the front and back beams.

b. TO INTERCEPT THE LOCALIZER BEAM.—Turn on the localizer receiver. After the initial warm-up period note the indication of the localizer needle. It will be deflected to either side and will show the sector (blue or yellow) in which the aircraft is flying.

The aircraft must then be flown on a heading which will intercept the localizer beam. If the aircraft is in the *yellow* sector, this heading will be the inbound bearing of the front beam *plus* 90°. See Figure 11. If the aircraft is in the *blue* sector, this heading must be the inbound bearing *minus* 90°. See Figure 12.

Proceed on this heading until the beam of the localizer is intercepted.

c. TO IDENTIFY POSITION ON THE LOCALIZER BEAM.—The pilot must now determine which of

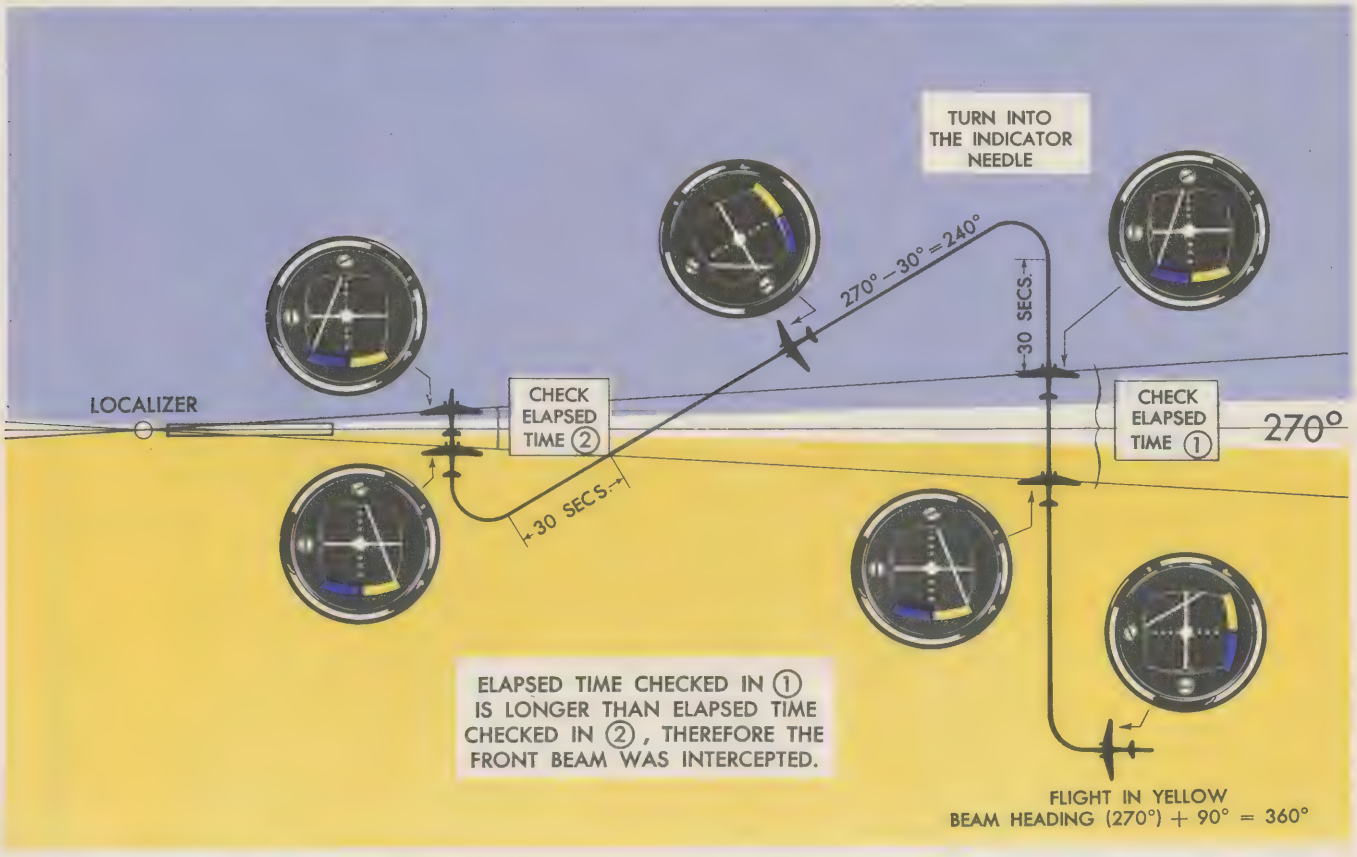


Figure 11—Orientation (Front Beam)

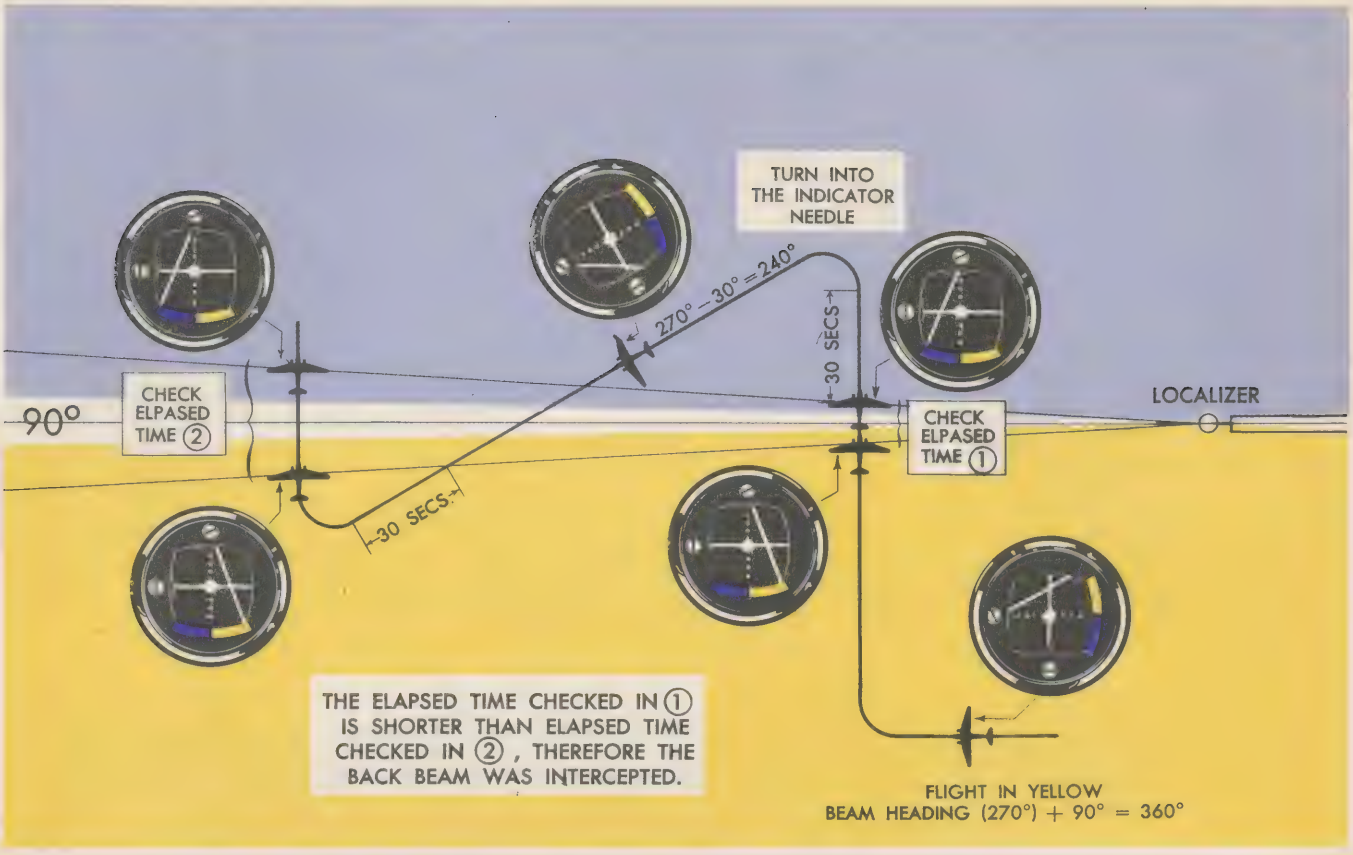


Figure 12—Orientation (Back Beam)

the beams, either front or back, has been intercepted. The procedure for such identification is as follows:

(1) Maintain the established heading (±90° to the beam heading) until the aircraft begins to cross the beam. At this time the needle will start to swing from full-scale deflection toward center.

(2) Note the time when the needle first shows a two-dot deflection. Continue flight through the beam and note the elapsed time when the needle shows a two-dot deflection on the opposite side. This will indicate the width of the beam at the point of crossing.

(3) Maintain the original heading until 30 seconds beyond a full-scale deflection, then make a 120° standard-rate turn toward the needle. This will bring the aircraft back across the beam at a 30° angle.

(4) Hold this heading until 30 seconds beyond a full-scale deflection, then make a 120° standard-rate turn *toward* the needle, back to the heading at which the beam was *originally* crossed.

(5) Hold this new heading and time the width of the beam as before.

(6) If this elapsed time is *less* than the first timing, the *front* beam was intercepted.

If this time is more, the *back* beam was intercepted.

(7) From the position thus determined, turn to fly on-course toward the marker stations and proceed with the approach.

d. MISCELLANEOUS.

An orientation problem may also be solved by flying along the localizer beam and checking the localizer identification signal for a volume fade or build. This method, however, is difficult and unsatisfactory, due to a strong Automatic Volume Control action in the localizer receiver.

RESTRICTED

TECHNICAL ORDER NO. 30-100F-2

INSTRUMENT FLYING

ARMY AIR FORCES

INSTRUMENT APPROACH SYSTEM INSTRUCTORS' SYLLABUS

PUBLISHED BY AUTHORITY OF THE COMMANDING GENERAL
ARMY AIR FORCES

15 JANUARY 1945

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INTRODUCTION

The actual flight procedures of the AAF Instrument Approach System are not difficult and are very similar to those used in radio range flying. However, regardless of the simplicity of flight procedures and technique, no instructional success can be achieved unless the student has a complete ground knowledge of the operation of the system. Accordingly, before any attempt is made to instruct students on the ground or in flight, it is imperative that the instructor have an excellent knowledge of the information contained in T. O. 30-100F-1, AAF Instrument Approach System, and understand the use of T. O. 08-15-4.

The student will grasp the principles of the AAF Instrument Approach System much more quickly if drawings and diagrams are used to illustrate the relationship of the various units (localizer, glidepath, and marker beacons) to the landing runway. Early in the discussion it should be stressed that the localizer and glidepath units are independently operated units. Their only connection lies in the fact that both units in the aircraft are turned on by the same switch, and both indicator needles are in the same instrument.

Following this line of thought, the student is introduced to the elements of the approach system one at a time. Instruction on the localizer is given first. The student has had experience in following radio range beams by aural reference. Now it is relatively simple to utilize this knowledge when teaching him to follow the localizer beam by *visual* reference to the localizer needle.

The glidepath is taken up next; it may be compared to a localizer beam turned on its side. Finally the student is taught to coordinate the use of both the localizer and glidepath beams, and to make proper use of the marker beacons.

Follow the lesson outlines closely. Accentuate the simplicity, accuracy and dependability of the system. Discourage mechanical techniques, and have the student conduct flight on the localizer and glidepath beams just as he would on a radio range beam.

This syllabus contains three lessons. The material for each lesson is presented in three parts: (1) a brief note on the purpose of the lesson; (2) an outline of the lesson; and (3) a guide for the instructor, which covers in detail each point of instruction contained in the lesson outline.

LESSON I

I OBJECTIVE

To give the student an overall picture of the AAF Instrument Approach System. To teach the student how to intercept and follow the localizer beam and to make procedure turns. To teach him procedures of orientation on the localizer beam.

II LESSON OUTLINE

A. BEFORE TAKE-OFF.

1. Explain the operation of the AAF Instrument Approach System (SCS-51).
2. Explain the localizer beam and the localizer needle indications.
3. Explain how to intercept and follow the localizer beam.
4. Explain procedure turns.
5. Explain localizer orientation procedures.

B. LESSON IN THE AIRCRAFT.

1. Demonstrate the localizer needle indications.
2. Demonstrate proper method of intercepting and following the localizer beam.
3. Student practices intercepting and following the localizer beam, and procedure turns.
4. Have the student practice orientation on the localizer beam.
5. Land and hold critique.

III INSTRUCTOR'S GUIDE

A. BEFORE TAKE-OFF.

1. EXPLANATION OF THE AAF INSTRUMENT APPROACH SYSTEM (SCS-51).

a. Using T. O. 30-100F-1 as reference, tell the student that the AAF Instrument Approach System has been designed to permit a pilot to execute a safe landing when ceiling and visibility restrictions are so low as to prohibit normal instrument flight operations. Tell him that an actual instrument landing is not the real purpose of the system. Rather, the AAF Instrument Approach System is a means by which the pilot may safely descend to a position a few feet above a runway or landing strip, from which point the actual landing will then be accomplished by visual reference to the ground. Explain that the abbreviation, SCS-51, means Signal Corps Set No. 51. This equipment consists of a Glidepath Transmitter, a Runway Localizer Transmitter and three 75 megacycle Marker Beacon Transmitters. Each of the units are independently operated, and they constitute the ground equipment of the AAF Instrument Approach System.

b. The AAF Instrument Approach System, using SCS-51, provides the pilot with a straight-line glidepath beam and a runway localizer beam. Tell the student that the localizer beam provides him with a course which, if followed correctly, will bring the aircraft directly over the landing runway. The glidepath beam will provide a safe descending path to the runway. Together, they create a safe and accurate flight path from the initial approach altitude to a point above the landing runway from which a landing may be accomplished by reference to the ground.

c. To enable the pilot to follow the two beams, the aircraft is equipped with an Approach Indicator. This instrument has two crossed needles. The vertical needle supplies a visual indication of the position of the aircraft with respect to the on-course of the localizer beam. The horizontal needle shows the relationship of the aircraft to the glidepath beam. When the aircraft is properly aligned on the approach path, the needles of the Approach Indicator are crossed in the center of the instrument.

d. The three markers inform the pilot of (1) his distance in miles from the landing runway, and (2) whether the aircraft is above or below the desired altitude on the final approach. Tell the student the location of the markers on the local SCS-51 installation. Elaborate only on (1), as a detailed explanation of (2) is not required until Lesson II.

> **NOTE:** The sequence of instruction calls for a separate discussion of the glidepath beam and glidepath needle indications. Detailed explanation of this phase of the AAF Instrument Approach System is not to be given in the first lesson.

At this time instruct the student how to operate the equipment in the aircraft.

2. EXPLANATION OF THE LOCALIZER BEAM AND THE LOCALIZER NEEDLE INDICATIONS.

a. Explain to the student that the localizer beam is similar to a two-course radio range and is created by the runway localizer transmitter. This transmitter is crystal-controlled to one of six available frequencies. The signal is split at the transmitter; one sector is modulated at 90 cycles per second, and is designated as the *yellow* sector. The other sector is designated as *blue,* and is modulated at 150 cycles per second. Explain that the color designations are only for convenience in flight. Refer the student to a suitable diagram or illustration. Tell him that the blue sector is always transmitted to the right of the beam with respect to the landing aircraft on the final approach; the yellow is always transmitted to the left.

b. Point out that like the radio range "on-course," the localizer beam is formed by the overlapping of two signals. The "on-course" is that area in which the field strength of the two signals is equal. The Approach Indicator installed on the instrument panel will indicate, by deflection of the vertical needle, the color area of the sector in which the aircraft is flying. If the aircraft

is flying in the blue area of the transmitter, the needle will be deflected to the blue area of the indicator. If the aircraft is flying in the yellow sector, the needle will be deflected into the yellow area of the indicator. Emphasize that the deflection of the needle does not necessarily indicate the direction toward the beam.

c. Use available diagrams, illustrations and mock-ups to instruct the student in the proper interpretation of the localizer needle indications. Tell him that when the aircraft is flying on the front beam of the localizer and is headed *toward* the runway, the action of the needle may be considered as directional. That is, when the needle is deflected to the right, the aircraft must be turned to the right to regain the center of the localizer beam. This needle action also applies when flying on the back beam and the aircraft is headed *away* from the station transmitter. Point out that when flying a reciprocal heading of the localizer beam, the action of the needle is reversed. In this case, to regain the center of the localizer beam, the direction of turn must be away from the needle.

NOTE: The blue and yellow sectors and the indications of the localizer needle are sometimes confusing to students. They often associate the color sectors with their left or right. Try to avoid this misunderstanding. Make certain the student understands that, regardless of heading of the aircraft, the needle will always be deflected to the color area of the approach indicator that corresponds to the color of the sector in which the aircraft is flying.

d. Tell the student that the localizer beam will cause a full-scale deflection of the localizer needle when the aircraft is 3.5 degrees to either side of the runway centerline. When the aircraft is directly on-course, the needle will be centered. With a normal installation the point of landing is approximately 6,000 feet from the localizer transmitter. A full-scale deflection at this distance would mean that the aircraft is 350 feet from the center of the runway. Emphasize that to insure a successful and accurate approach, the *needle must be kept less than 1/4 scale off center.*

3. EXPLANATION OF HOW TO INTERCEPT AND FOLLOW THE LOCALIZER BEAM.

a. Tell the student that installations of the AAF Instrument Approach System normally will be located only at those airfields which are equipped with radio range facilities. The aircraft will be flown to the radio range station as in normal airways flying. After arrival over the range station, the pilot must fly a course which will intercept the localizer beam. As he approaches the beam, attention should be directed toward the localizer needle. As the aircraft starts to cross the localizer beam, the needle will start to move from the original full-scale deflection toward center. *As soon as this movement begins, the aircraft should be turned to the outbound heading of the front localizer beam.* This procedure should place the aircraft close enough to the center of the on-course so that subsequent following of the beam may be easily accomplished. Point out that "anticipation" of the "on-course" is the same, and must be used as in radio range flying.

b. To bracket or follow the localizer beam, the technique used is the same as in following a radio range beam. Instruct the student that corrections should be small, and must be made immediately upon observing any deflection of the vertical needle from center position. Assure him that, although the localizer beam is very narrow, because of the *visual* indication of position, the desired degree of accuracy is not difficult to attain. Frequent cross-check of the directional gyro and localizer needle is most important, and must be made to determine the exact beam heading.

c. It is advisable at this time to again review the action of the needle on outbound and inbound headings. Check the student's understanding of the blue and yellow sectors. Make sure he understands these points perfectly. Remind him once more that a less than 1/4 scale deflection on the final approach is necessary to insure a successful landing.

4. EXPLANATION OF PROCEDURE TURNS.

A procedure turn on the localizer beam is essentially the same as that used on radio range, and is accomplished in the same manner. To execute a procedure turn on the localizer beam, a 45 degree turn is made away from the localizer beam. This new heading is held for 40 seconds. The pilot will then start a turn back toward the beam until he has reached the inbound heading. Caution the student that this time must be observed closely. This is necessary because of the narrow width of the beam and, under normal conditions, should place the aircraft close to the center of the on-course. The time at which the procedure turn is to be made will be determined by the particular SCS-51 installation being used. T. O. 08-15-4 contains all necessary information.

NOTE: The landing cockpit check, i.e., lowering landing gear, checking gas, etc., is to be made when the aircraft first passes over the range station or "H" facility, and before using the localizer-glidepath equipment. It will not be necessary for the student to perform such check until Lesson III. However, if the instructor so desires, this check may be required of the student in Lessons I and II. If this is the case, the check will be made at the time the procedure turn is started.

5. EXPLANATION OF LOCALIZER ORIENTATION PROCEDURES.

a. Explain to the student that under normal conditions the localizer-glidepath course will be intercepted from some known position such as a radio range, or radio homing station. However, circumstances may arise when these facilities cannot be utilized because of failure of either ground or aircraft equipment. If the localizer-glidepath receiver is still operative and the localizer-glidepath transmitters are working properly, a localizer orientation problem can be flown and an approach completed. Instruct the student that the fundamentals

of such a problem consist of:

(1) Identification of the localizer signal received.

(2) Interception of the localizer beam.

(3) Identification of position on the localizer beam.

b. Instruct the student that dead reckoning navigation must be used to place the aircraft within receiving distance of the localizer transmitter. The aircraft equipment will be turned on and the station signal verified. The localizer needle of the Approach Indicator is then observed to determine in which color sector the aircraft is flying. If the aircraft is flying in the *yellow* sector, the heading flown to intersect the localizer beam will the *inbound bearing of the front beam plus 90 degrees.* If the aircraft is in the *blue* sector, this heading must be the *inbound bearing minus 90 degrees.* This heading will be flown until the beam of the localizer is intercepted.

c. Once the aircraft has intercepted the localizer beam, the student must then determine whether he has intercepted the front or back portion of the beam. This phase of identification is accomplished by timing the width of the beam at two different points.

NOTE: At this time the instructor will cover in detail, using diagrams and board drawings, the required procedure for such identification. Emphasize the importance of closely observing the time required to cross the beam at each point. In the timing procedure all turns are made *toward* the needle.

Once the pilot has identified his position, the approach is to be completed in the usual manner. Make this explanation clear, and be certain that the student thoroughly understands all the procedures of localizer orientation. This *must* be done as a demonstration in flight of these procedures is of little value, and will not be given unless absolutely necessary.

B. LESSON IN THE AIRCRAFT.

1. DEMONSTRATION OF THE LOCALIZER NEEDLE INDICATIONS.

a. While the aircraft is parked on the ramp, the instructor will turn on the aircraft equipment and have the student note the indications of the Approach Indicator. Tell him that the indications received will act as a *ground check of the equipment.* The glidepath needle should be deflected upward, and the localizer needle should be at a full-scale deflection in the color area of the Approach Indicator that corresponds to the color sector of the beam in which the aircraft is parked. Instruct him that this check should be made prior to all instrument flights. If these indications are not as they should be, a radio mechanic will have to make necessary adjustments before the set can be safely used.

b. The instructor will take off and climb to a working altitude. This altitude should be one that will allow the student a clear view of the landing runway, and enable him to compare needle indications with same.

c. First demonstrate that the needle will always be deflected to the color area of the Approach Indicator which corresponds to the color area in which the aircraft is flying. Fly the aircraft on several different headings in each of the color sectors. Point out that, regardless of the heading or direction of the aircraft, the needle will always be deflected into the color area of the Approach Indicator that corresponds to the color area of the localizer transmitter signal in which flight is being conducted. Now fly the aircraft across the beam at a 90 degree angle. Call the student's attention to the localizer needle as it moves from full-scale deflection, past center, to a full-scale deflection into the opposite color sector. Have the student observe the relationship of the aircraft to the runway as the needle passes center. Demonstrate this close to the transmitter and at a distance of 5 miles or more. This will show the relative width of the beam at the two points.

d. Fly the aircraft along the localizer beam and have the student observe that when the vertical needle is centered, the aircraft is in line with the landing runway. Conduct flight to one side of the beam and point out the resulting indications of the needle. Show the student that when the aircraft is on the final approach, it will not be properly aligned with the runway when the needle has a more than ¼ scale deflection. Emphasize once again the importance of accuracy to insure a successful approach.

As the aircraft passes over the localizer transmitter, point out that the needle will be deflected rapidly from side to side. Tell the student that such indication may be used to check his position on the beam. At the same time caution him that such needle reaction, though occurring in the majority of cases, will not happen *every* time the aircraft passes over the transmitter, and should not be relied upon as a final check of position.

2. DEMONSTRATION OF INTERCEPTING AND FOLLOWING THE LOCALIZER BEAM.

a. When certain the student understands the indications of the localizer needle and the importance of accuracy when following the localizer beam, the instructor will demonstrate how to intercept the beam, and the proper technique used to follow same. With the hood open, fly from the range station or some other point to the side of the beam, properly intercept, and follow the beam to the transmitter. As the aircraft first approaches the beam, have the student note that as soon as the needle *starts* to move from full-scale deflection toward center, a turn is made to the beam heading. Remind him that this is done because of the narrowness of the beam, and if the turn is not started at this time the radius of turn of the aircraft will carry it through the beam to the off-course zone on the other side.

b. Demonstrate the control technique used to follow the localizer beam. Stress the importance of following the beam centerline to determine the exact heading of the beam. Remind the student that frequent cross-check of the directional gyro and vertical needle is necessary. Have him note that as soon as any drift is detected, a corresponding change in heading must be made. This

corrective heading is held until the aircraft is back on course. Then a turn is made toward the old heading, less necessary allowance for the drift.

c. Throughout the demonstration the instructor should repeatedly remind the student of the similarity of procedures used when following the localizer beam, and those used when following the radio range beam. Convince him the only difference is that one is flown by *aural* signals, and the other by *visual* signals. The principles of correction, "anticipation" of the on-course and establishing the beam heading are the same in both cases.

d. The instructor will continue following the localizer beam on the outbound heading until 3 or 4 minutes away from the transmitter, and then properly execute a procedure turn. Remind the student again that the turn is the same as on the radio range. Stress the importance of timing.

3. STUDENT PRACTICE ON THE LOCALIZER BEAM.

a. The instructor will place the aircraft well off-course and about 10 miles from the transmitter. Then have the student take over, and with the hood open, intercept and follow the localizer beam to the transmitter. Watch closely for any attempt by the student to overcorrect. Make sure that all his turns are coordinated, and do not allow him to make rough skidding corrections. Insist that he keep the aircraft close to the beam centerline, not allowing it to get too far off course before making corrective turns.

b. Observe the student's technique used to establish an accurate beam heading. See that he remembers which headings will take him away from the beam and which will bring him back. Remind him that as the transmitter is approached, the beam will narrow; hence, it is most important that the beam heading be determined as quickly and accurately as possible.

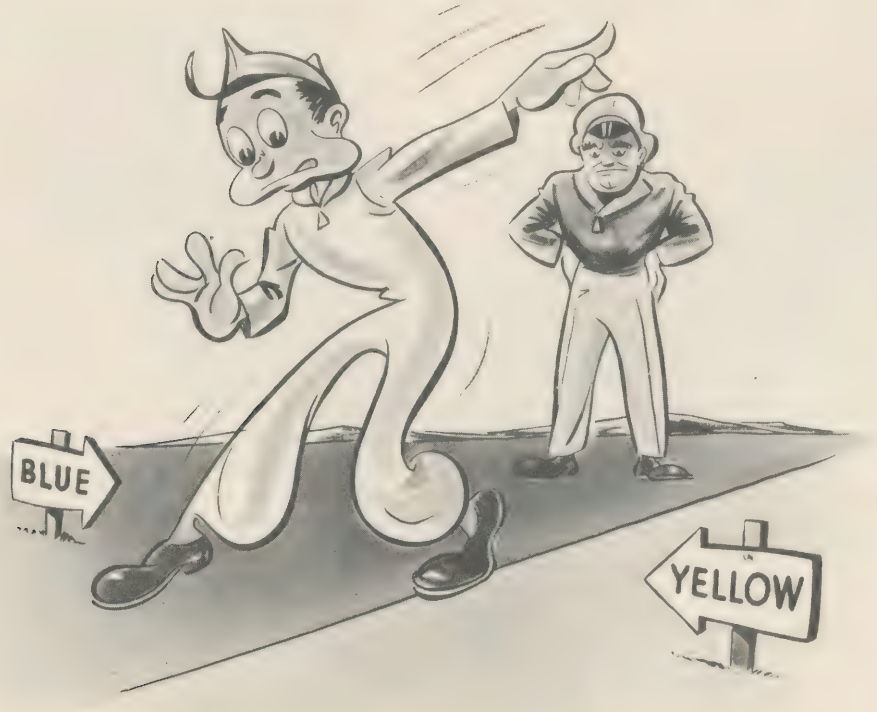
c. As the aircraft passes over the transmitter, the localizer needle may be expected to deflect from side to side. Have the student signify this by shaking the stick. Then have him observe the alignment of the aircraft to the landing runway. Allow him to continue flight along the beam until about 10 miles from the transmitter. Then have him make a procedure turn.

d. Now have the student go under the hood and practice intercepting and following the localizer beam and making procedure turns until a reasonable proficiency has been attained. Repeat any demonstration deemed necessary—stress accuracy—make sure the needle indications are interpreted correctly.

4. STUDENT PRACTICE OF ORIENTATION PROCEDURES.

Demonstration of localizer orientation procedures should not be necessary. The instructor will proceed to "lose" the student and have him work an orientation problem. Once the position on the localizer beam has been determined, the student will follow the beam to the boundary marker. Repeat this until the end of the period.

5. LAND AND HOLD CRITIQUE.



LESSON II

I OBJECTIVE

To teach the student how to intercept and follow the glidepath beam. To teach him how to follow the localizer and glidepath beams on the final approach.

II LESSON OUTLINE

A. BEFORE TAKE-OFF.

1. Explain the glidepath beam and the needle indications.
2. Explain how to intercept the glidepath beam.
3. Explain the proper control techniques used on the final approach.
   a. How to establish the descent.
   b. How to use the marker beacon indications.
   c. How to make corrections on the final approach.

B. LESSON IN THE AIRCRAFT.

1. Demonstrate the glidepath needle indications.
2. Demonstrate how to complete the final approach.
   a. How to establish the descent.
   b. How to follow the glidepath and localizer beams simultaneously.
3. Have the student practice making the final approach.
4. Land and hold critique.

III INSTRUCTOR'S GUIDE

A. *BEFORE TAKE-OFF.*

1. EXPLANATION OF THE GLIDEPATH BEAM AND NEEDLE INDICATIONS.

a. THE GLIDEPATH BEAM.—Explain that the glidepath beam, just like the localizer beam, is formed by the overlapping of two ultra high frequency radiation fields. The transmitter is operated at a position 400 to 700 feet upwind from the approach end of the runway and a maximum of 400 feet to one side of the runway centerline. It is a mobile unit and can be made to operate on either side of the runway. Point out that the glidepath "on-course" lies in a nearly *horizontal* plane. Tell the student the angle at which the local glidepath beam is projected. At the same time remind him that it may vary on other installations, depending upon the local terrain requirements. The glidepath beam is directed along the front beam of the localizer. The beam is extremely narrow and has a width of only .8 degree.

NOTE: Although the glidepath and localizer beams are independent of one another, it is extremely important that the student has a clear mental picture of their physical relationship. The instructor should use any mock-up available, and will use all pertinent diagrams and illustrations contained in T. O. 30-100F-1 to present to the student a three dimensional picture of this phase of the AAF Instrument Approach System. Even though the ground discussion for this lesson is devoted almost exclusively to the glidepath, all explanations should include continual reference to the localizer and the coordinated use of both beams.

b. INDICATIONS OF THE GLIDEPATH NEEDLE.—Tell the student that interpretation of the glidepath needle indications is comparatively simple. The glidepath needle will *always* point toward the beam regardless of the heading or position of the aircraft. If the aircraft is flying *above* the beam, the needle will be deflected *downward;* if the aircraft is *below* the beam, the needle will be deflected *upward.* A full-scale deflection is received when the aircraft is .5 degree below the glidepath, while if only .3 degree above the beam, the needle will be in a full-scale upward position. Explain that if the receiver is on, and no signal is being received, the needle will remain in a fly-up position at all times. Tell him that this is a safety feature and will prevent him from flying the aircraft into the ground should either the transmitter or the receiver fail.

2. INTERCEPTING THE GLIDEPATH BEAM.

Show the student that the glidepath crosses the outer marker beacon at an altitude of approximately 1050 feet above the ground. This is true of most SCS-51 installations. Therefore, if flight along the localizer beam is conducted toward the station at this altitude, the glidepath beam will be intercepted at the outer marker beacon. All standard flight procedures are designed to have the pilot use this method to intercept the glidepath beam. Point out to him that interception of the glidepath beam presents no special problem, and that no special procedures are necessary.

3. CONTROL TECHNIQUES ON THE FINAL APPROACH.

a. ESTABLISHING THE DESCENT.—As the aircraft enters the glidepath, the needle will begin to move down from its full-scale upward deflection. Instruct the student that as it comes within one-quarter scale of center, the power setting is to be reduced to the value which will result in the rate-of-descent necessary to stay on the glidepath at the desired airspeed. This power setting will vary with the type aircraft flown and should be made known to the student before flight. The forward momentum will carry the aircraft into the glidepath beam and the needle should be centered by the time the actual descent begins. Once the beam has been entered and the descent established, the power setting should not be varied until the approach is completed. Stress this. Excessive use of throttle will result in overcontrolling of attitude, and airspeed, and consequent loss of the beam.

b. MARKER BEACON INDICATIONS.—When explaining the indications of the marker beacons and the altitude of the glidepath beam as it crosses each, the instructor will use a profile diagram of the marker beacons and glidepath beam to present the picture to

the student. The illustration contained in T. O. 30-100F-1 is recommended. Also, because the altitude of the beam over the markers will vary with different SCS-51 installations, the instructor will previously flight check the local installations so that the exact altitudes can be told to the student. Explain that the marker beacons are included in the SCS-51 primarily to act as a check on the proper operation of the glidepath. Now, proceed to tell the student the exact altitudes at which each will be crossed. Impress upon the student the importance of checking the altimeter every time he receives a marker beacon indication.

NOTE: An explanation of, and flight instruction on, the procedures of accomplishing an approach on the localizer beam alone is not required. However, at those fields where sufficient instructional time is available, or a student is above average, such instruction is recommended. Complete procedures for a localizer letdown are contained in T. O. 30-100F-1.

c. CORRECTIONS ON THE FINAL APPROACH. —Tell the student just what he is required to do on the final approach. Point out that he must follow the localizer and glidepath beams simultaneously. He must check his altitude over each of the marker stations. In addition, he must constantly maintain a safe airspeed and an accurate rate of descent. It is expected that corrections will be necessary.

Remind him that corrections on the localizer may be necessary because of changes in wind velocity and direction as altitude is decreased. At the same time, corrections on the glidepath may also have to be made. *In both cases all corrections will be made toward the needles.* If the aircraft is to one side of the localizer at any time, special care must be exercised to avoid overcorrection. All turns should be *small.* Large sweeping turns are undesirable, and if the localizer heading was properly established before starting the final approach—*unnecessary.* Give the aircraft time to react to a correction. If the aircraft should get *above* the glidepath, merely lowering the nose of the aircraft slightly should bring it back on the glidepath beam. If *below* the glidepath beam at any time, raise the nose of the aircraft slightly, *fly level and maintain a constant altitude* until the "on-course" indication is received. Instruct the student that if corrections on the glidepath and localizer are needed at the same time both corrections will be coordinated. The necessary change in attitude and heading will be made simultaneously. Cover in detail all possible indications that may be shown by the Approach Indicator and specifically explain what correction is to be made in each case. Stress the following rules.

(1) *Make all corrections toward the needles.*

(2) *Do not make large changes of attitude.*

(3) *Do not make large changes of heading.*

(4) *Do not make any large corrections near the ground.*

(5) *Do not be too proud to pull up and go around.*

B. LESSON IN THE AIRCRAFT.

1. DEMONSTRATION OF THE GLIDEPATH NEEDLE INDICATIONS.

a. Have the student make an instrument take-off and climb to a working altitude. When about five miles from the glidepath have the student open the hood. Take over the control of the aircraft and demonstrate the indications of the glidepath needle. Fly through the beam and have the student note the resulting indications of the needle. Now fly through the beam about one mile from the transmitter; point out the extreme narrowness of the beam at this point.

b. With the hood remaining open, have the student take over and demonstrate these points for himself.

2. DEMONSTRATION OF THE FINAL APPROACH.

a. The instructor will take over control of the aircraft and fly out the front beam of the localizer until the proper time for the procedure turn. Make a regular procedure turn and follow the localizer beam toward the station until the glidepath is intercepted. When this occurs have the student note the marker beacon indication and the reaction of the glidepath needle.

b. Now fly out the localizer beam again, and execute another procedure turn. Follow the beam until the glidepath is intercepted once again. This time complete the final approach. Accuracy is desired, and the student's attention should be directed to the indications of the needles and the control technique used to make any necessary corrections. Now allow the student to make a final approach (hood open).

c. Demonstrate the proper method of making corrections on the final approach.

(1) Purposely place the aircraft below the glidepath and demonstrate the correct method of regaining the "on-course." Point out to the student that *no climb* is necessary and that merely maintaining level flight will bring the aircraft satisfactorily back on "course."

(2) Now place the aircraft above the beam and demonstrate the procedure for regaining the "on-course" from this position.

(3) Demonstrate the proper procedure used to make all other possible corrections on the final approach, i.e., to the side of the localizer beam and above the glidepath; to the side of the localizer and below the glidepath. Emphasize that in these instances the necessary pitch attitude and heading corrections are to be executed *simultaneously.*

3. STUDENT PRACTICE.

4. LAND AND HOLD CRITIQUE.

LESSON III

I OBJECTIVE

To teach the student standard instrument approach procedures and the proper voice procedures to be used.

II LESSON OUTLINE

A. BEFORE TAKE-OFF.

1. Explain the three procedures used to fly from the range facility to the localizer beam. (Emphasize the one to be used in this lesson.)
2. Explain proper voice procedures.

B. LESSON IN THE AIRCRAFT.

1. Review weak points of the previous lessons.
2. Student practices all phases of the AAF Instrument Approach System.
3. Land and hold critique.

III INSTRUCTOR'S GUIDE

A. BEFORE TAKE-OFF.

1. EXPLANATION OF PROCEDURES USED TO FLY FROM RANGE FACILITY TO LOCALIZER BEAM.

a. Tell the student that once the aircraft has arrived over the range station or "H" facility, one of the three procedures must be used to intercept the localizer beam. Selection of the procedure will be determined by the location of the range or "H" facility to the localizer beam. Point out that in the majority of cases the SCS-51 installation and the range station will come under one of the following relationships:

(1) The range station or "H" facility is on the front beam of the localizer.

(2) The range station or "H" facility is on the back beam of the localizer.

(3) The range station or "H" facility is to one side of the localizer beam.

b. Cover in detail the procedure used when the range station or "H" facility is on the front beam of the localizer. Use T. O. 30-100F-1 or T. O. 08-15-4, and show the student the instrument approach procedure established for Bryan, Texas. Here the localizer beam is coincident with the northwest-southeast leg of the Bryan range. The range station is aligned with the landing runway and is approximately 4.5 miles from the point of landing. The "Z" marker at this station is used on the outer marker beacon of the localizer. Point out that the station is on the front beam of the localizer and that an arrival over the Bryan range also places the aircraft on the localizer beam.

A pilot approaching Bryan under instrument conditions will fly to the range station or "H" facility on the same site. Upon passing over the station he will turn to the outbound heading of the localizer beam and descend to the desired altitude. Flight is conducted out the localizer beam until the glidepath needle swings upward and for two minutes thereafter. A normal procedure turn is accomplished and the approach completed in the usual manner.

Tell the student that this is the procedure to be used on all similar installations. Altitudes and time will vary, but in each case the general procedure will be the same.

c. When explaining the procedure to be used when the range station or "H" facility is on the back beam of the localizer, again use T. O. 30-100F-1 or T.O. 08-15-4 and explain the installation that is used at Barksdale, La. Point out that in this case the range station is on the back beam of the localizer. Upon crossing the range station the pilot will bracket the localizer beam toward the field. Remind the student that passage over the transmitter will be indicated by a rapid deflection of the localizer needle from side to side. Flight is continued past the outer marker beacon for the specified time until the procedure turn is started.

d. Using the same Technical Orders as above, explain the procedure for Lockbourne, Ohio. In this case, the range station is located to the side of the localizer beam. Flight is conducted from the range station by dead reckoning on a heading perpendicular to the localizer beam heading. When the vertical needle of the pilot's Approach Indicator shows that the beam has been reached the aircraft is turned to the beam heading and bracketing is started.

NOTE: The before-landing cockpit check will be made and the landing gear lowered as the aircraft first passes over the range station or "H" facility. A *re-check* of the landing gear will be made while executing the procedure turn.

2. EXPLANATION OF THE PROPER VOICE PROCEDURES.

Tell the student that prior to crossing the range station regular radio voice procedures are to be used. As the range station is crossed, the only additional voice procedure necessary to fly the AAF Instrument Approach System is to request an approach clearance. Unless otherwise instructed by the tower, no other voice procedure is required. Although not actually part of the localizer voice procedure, it is advisable to remind the student at this time of the importance of altimeter setting. Point out that altimeter setting is of utmost importance when visibility and ceiling are so low as to require the use of the instrument approach system, and an instrument let-down to a very low altitude is anticipated.

B. LESSON IN AIRCRAFT.

1. REVIEW.

The instructor will conduct a review of those points of the previous lessons that have caused the student

difficulty. Special attention should be directed to the accuracy of the student's work, and the use of proper control technique when following the localizer and glidepath beams. Review orientation procedures if necessary.

2. STUDENT PRACTICE OF THE AAF INSTRUMENT APPROACH SYSTEM.

a. After the review is over, the instructor will turn off the localizer-glidepath equipment and have the student execute basic maneuvers until he no longer knows his position. When convinced that the student is disoriented, turn on the localizer and glidepath receiver. Have the student fly a localizer orientation problem and complete an instrument approach.

b. Again turn off the localizer-glidepath equipment and have the student climb to a suitable altitude for range flying. Once the desired altitude is reached, turn on the aircraft equipment and have the student bracket the radio range beam to the station; from there complete another instrument approach on the localizer and glidepath beams. Throughout this second phase insist upon proper voice procedure and the before landing check.

3. LAND AND HOLD CRITIQUE.